

ONLY USE WITH CONSENT OF BITUMINOUS OFFICE

S-1 (2360) HOT MIXED ASPHALT - POROUS PAVEMENT

The provisions of the attached **Combined 2360/2350 (Gyratory/Marshall Design) Specification** of these Special Provisions is hereby modified as follows in order to use the porous pavement as part of providing for storm water treatment.

Bituminous material shall be PG (Performance Grade) PG 64-22. The use of recycled material, RAP or shingles, is not allowed. Design asphalt content by weight shall be in accordance to MnDOT 2360 (Table 2360.2E (as modified below), Table 2360.3-B2a and Table 2360.3-B2b)

S-1.1 DESCRIPTION

This work consists of the construction of a Porous Hot Mix Asphalt Wearing Course Mixture (Porous HMA). The work shall be in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross-sections shown on the plans or established by the Engineer.

S-1.2 MATERIALS

(A) 2360.2E (Gradation Requirement) is hereby modified as follows:

Mineral aggregate shall meet aggregate size B gradation as modified below in Table 2360.2-E for the type and thickness of mixture specified.

**Table 2360.2-E
Aggregate Gradation Broad Bands
(% passing of total washed gradation)**

Sieve Size, mm (inch)	Porous HMA
19.0 (¾")	100
12.5 (½")	85-100
9.5 (3/8")	55-75
4.75 (#4)	10-25
2.36 (#8)	5-10
0.075 (#200)	2-4

(B) 2360.2C1 is hereby modified to read:

The Los Angeles Rattler loss on the coarse aggregate fraction (material retained on the 4.75-mm [#4] sieve) shall not exceed 35 percent for any individual source used within the mix.

(C) 2360.2F is hereby modified to read:

F Additives

An additive is any material added to an asphalt mixture or material, such as mineral filler, asphalt additives, anti-strip, stabilizers, and similar products that do not have a specific pay item. When a Contract requires additives, compensation is included with the pay items for the appropriate mixture. If the Engineer directs the Contractor to incorporate additives, the compensation will be as Extra Work, at the unit price specified in the proposal. The Contracting Authority will not compensate the Contractor for additives incorporated at the Contractor's option.

Additives shall not be incorporated into the mixture without approval of the Engineer. Anti-foaming agents shall be added to asphalt cement at the manufacturer's recommended dosage rate.

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F1 Mineral Filler. AASHTO M17

F1a Composition

Mineral filler shall consist of carbonate dust, Portland cement, hydrated lime, crushed rock screening, or rotary limekiln dust.

Crushed rock screenings to be used as mineral filler shall be of such composition and quality that the bituminous mixture containing the rock screenings will have stability and durability equivalent to those of the comparable mixture containing one of the other acceptable filler materials. The rock screenings shall be free from clay and shale.

Mineral filler prepared from rock dust, slag dust, and similar materials shall be free from organic impurities and have a plasticity index not greater than 4 (AASHTO T 90).

F1a1 Hydrated Lime

Hydrated lime used in asphalt mixtures shall meet the requirements of ASTM C977 and have a maximum of eight percent unhydrated oxides (as received basis). The method of introducing and mixing the hydrated lime and aggregate shall be subject to approval by the Engineer prior to beginning mixture production.

F1b Gradation

Mineral filler shall be graded within the following limits:

Percent finer than 0.600mm (#30) 100

Percent finer than 0.300mm (#50)95-100

Percent finer than 0.075mm (#200)70-100

F1c Condition

Mineral filler that is to be added directly to the dried aggregate for the bituminous mixture shall be thoroughly dry and free from lumps consisting of aggregations of fine particles.

Crushed rock screenings used as mineral filler shall be of uniform gradation and shall be processed and handled in such a manner as will prevent segregation. The rock screenings shall be dried by passing through the dryer.

F1d Sampling and Testing

1) Sampling.....MnDOT Bituminous Manual

2) Fineness

Sieve Analysis AASHTO T 27

Hydrometer Analysis..... AASHTO T 88

(A) This procedure is modified to permit the use of Gum Arabic as a dispersing agent if flocculation occurs.

3) Plasticity Index AASHTO T 89 & 90

4) Specific Gravity..... AASHTO T100

F5 Porous HMA Asphalt StabilizerAASHTO MP8-02

An asphalt stabilizer additive shall be used to control drain-down. The stabilizer additive shall be a cellulose fiber conforming to AASHTO MP8-02.

The stabilizer supply system shall be a separate system that proportions the required amount of stabilizer in uniform distribution. The system shall include low level and no-flow indicators and a printout of status of feed rate in lbs/min. The stabilizer supply line shall include a section of transparent pipe for observing consistency of flow or feed. Stabilizer dosage rate shall be within 0.2-0.4 percent by weight of the total mix.

(D) Section 2360.2G is added to read:

G Asphalt Binder Material AASHTO M 320

The asphalt binder material shall be PG 64-22

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S-1.3 MIXTURE DESIGN

(A) 2360.3A shall be modified to include:

- a) It shall be the Contractor's responsibility to design the porous asphalt mixture such that it meets the requirements of this specification. Test method ASTM D6752 Mn/DOT modified (Corelok) shall be used to determine mixture bulk specific gravity.
- b) All mixture shall be designated as wearing course.
- c) Additional information can be found in Appendix A of NAPA's Porous Asphalt Pavements, Quality Improvement Series 131, however these specs shall take precedence.

(B) 2360.3B1 shall be modified to include:

B1a Desired Aggregate Blend

At least 7 working days prior to the start of asphalt production, the Contractor shall submit at least 150 lbs. of the coarse aggregate fraction from the selected design aggregate structure. This sample will be tested for the voids in coarse aggregate fraction (VCA_{drc}).

(C) Table 2360.3-B2a shall be modified to read as follows:

**Table 2360.3-B2a
Mixture Aggregate Requirements**

Aggregate Blend Property	Porous HMA
Coarse Aggregate Angularity (ASTM D5821) (one face), %- Wear & Non-Wear	55
Coarse Aggregate Absorption, % AASHTO T85, Mn/DOT modified	≤ 2
Fine Aggregate Angularity (FAA) AASHTO T304, Method A	N/A
Flat and Elongated Particles, max% by weight, (ASTM D 4791)	≤ 5 (5:1 ratio)
Clay Content (AASHTO T 176)	30
Total Spall in fraction retained on the 4.75mm (#4) sieve	2.5
Maximum Spall Content in Total Sample	2.5
Maximum Percent Lumps in fraction retained on the 4.75mm (#4) sieve	0.5

(D) Table 2360.3-B2b shall be modified to read as follows:

**Table 2360.3-B2b
Mixture Requirements**

Gyratory Mixture Requirements	Porous HMA
Gyrations for $N_{initial}$	N/A
Gyrations for N_{design}	50
Gyrations for $N_{maximum}$	N/A
Air Voids, % -- Wear	18%
Tensile Strength Ratio ⁽¹⁾ , min% at mix design	≥ 80
Fines/Effective Asphalt	≤ 1.2
Draindown - based on a 1 hour reading at the anticipated production temperature	≤ 0.3 %
Stabilizer by weight of total mix, %	0.2 – 0.4
VCA Ratio	$VCA_{MIX} < VCA_{DRC}$

(1) See 2360.4 E9. Use 150mm (6-inch) specimens for gyratory.

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- (E) Section 2360.3 B2d is hereby added:

B2d Minimum Asphalt Content

The guideline for percent asphalt binder shall be 5.5 to 6.5 percent by weight of mix.

- (F) Table 2360.3-B2c (VMA Mixture Requirements) shall be deleted

- (G) Table 2360.3-B3 shall be modified as follows:

Compacted briquette air void content for gyratory design shall be 17.0 – 19.0 %.

- (H) 2360.3C(10)(a) is hereby modified to read as follows:

Using the selected design gradation, prepare mixes at the three binder contents in increments of 0.5 percent. Conduct draindown test (AASHTO T305 or ASTM D6390) on loose mix at a temperature 15°C higher than anticipated production temperature. Compact mix using 50 gyrations of a Superpave gyratory compactor and determine air void contents.

- (I) 2360.3C(10)(g) is hereby modified to read as follows:

Test final mix for moisture susceptibility using the modified Lottman method (ASTM D 4867 MnDOT) Modified (~~AASHTO T283~~). Retained tensile strength (TSR) ≥ 80 percent

- (J) 2360.3C Additional Documentation for Gyration design is hereby modified to read as follows:

**Additional Documentation For:
Gyratory Design**

- (G1) The test results from the composite aggregate blend at the proposed JMF proportions indicating compliance with Coarse Aggregate Angularity, Fine Aggregate Angularity, and Flat and Elongated as shown in Table 2360.3-B2a.
- (G1a) For the trial blend(s), determine the Voids in the Coarse Aggregate-Dry Rodded Condition (VCA_{DRC}) according to AASHTO T19. The VCA ratio (VCA_{mix}/VCA_{DRC}) shall be less than 1.0, i.e. $VCA_{mix} < VCA_{DRC}$.
- (G2) The design number of gyrations at N_{design} .
- (G3) The temperature ranges the mixture is intended to be discharged from the plant and compacted at the roadway shall be provided by the asphalt binder supplier. Temperatures to be included are, laboratory mixing and compaction temperature ranges and maximum field mixing and compaction temperatures.
- (G4) Evidence that the completed mixture will conform to all specified physical requirements as follows: asphalt content and densification % G_{mm} at N_{design} , design air voids (V_a), TSR, Fines/Effective Asphalt, draindown, percent Stabilizer by weight of total mix, and VCA ratio.
- (G5) Labeled gyratory densification tables and curves, generated from the gyratory compactor, for all points used in the mixture submittal.
- (G6) Percent and manufacturer's data for type of stabilizer used.
- (K) 2360.3 D Modified Mixture Design (Option 2) is deleted.

S-1.4 MIXTURE QUALITY MANAGEMENT

- (A) 2360.4 D Sampling and testing second paragraph is hereby modified to read as follows:

The tests for mixture properties shall be conducted on representative portions of the mix, quartered from a larger sample of mixture taken from the truck box. The mixture shall be sampled from the truck box at the plant site after the truck has been fully loaded. The procedure for truck box

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sampling is contained on the Bituminous Office Web page at:
<http://www.mrr.dot.state.mn.us/pavement/bituminous/bituminous.asp>

Specifier personnel should monitor all samples obtained from the truck box. Due to mixture coarseness, sampling from the uncompacted mat behind the paver is discouraged.

(B) Table 2360.4-D is hereby modified to read as follows:

**Table 2360.4-D
Production Testing Rates**

Production Test	Testing Rates	Test Reference	Spec Section
Bulk Specific Gravity	1 test per 450 metric tons (500 tons)	ASTM D6752 Mn/DOT modified (Corelok)	2360.4E2a
Maximum Specific Gravity	1 test per 450 metric tons (500 tons)	AASHTO T209 Mn/DOT modified	2360.4E3
Air Voids (calculated)	1 test per 450 metric tons (500 tons)	AASHTO T269, T312	2360.4E4
Asphalt Content	1 test per 450 metric tons (500 tons)	Bit & Lab Manual	2360.4E1
Gradation	1 test per 900 metric tons (1000 tons)	AASHTO T11 & T27	2360.4E6
Coarse Aggregate Angularity	1 test per 900 metric tons (1000 tons)	ASTM D5821	2360.4E7
VCA Ratio (calculation)	1 test per 450 metric tons (500 tons)	AASHTO T19	2360.4E14
Draindown	1 test per 450 metric tons (500 tons)	AASHTO T305 or ASTM D6390	2360.3

(C) Table 2360.4-E is hereby modified to read as follows:

**TABLE 2360.4-E
PRODUCTION SAMPLING AND TESTING RATES**

Production Test	Sampling/Testing Rates	Test Reference	Section
Maximum Specific Gravity	"	AASHTO T209 Mn/DOT modified	2360.4E3
Air Voids (calculated)	"	AASHTO T269, T312	2360.4E4
Asphalt Content	"	Bit & Lab Manual	2360.4E1
Gradation	1 gradation per 1,800 metric tons (2,000 tons), or portion thereof (minimum of one per day)	AASHTO T11, T27, T30Mn/DOT modified	2360.4E6
Coarse Aggregate Angularity	2 tests/day for a minimum of 2 days, then 1 per day if CAA is met. If CAA >8% of requirement, 1 sample/day but test 1/week.	ASTM D5821	2360.4E7
Fine Aggregate Angularity (FAA)	N/A	AASHTO T304, Method A	2360.4E8
TSR	1 st sample at 5,000 tons or by second day of production, then sample at every 18,000 metric tons (20,000 tons)	ASTM D4867 Mn/DOT modified	2360.4E9
Aggregate Specific Gravity	1 per 9,000 metric tons (10,000 tons)	AASHTO T84 & T85, Mn/DOT modified	2360.4E10
Mixture Moisture Content	Daily unless exempted by Engineer	Mn/DOT 5-693.950	2360.4E11
Asphalt Binder	Sample 1 st load (each grade) then 1 per 1,000,000 liter (250,000 gallon-sample size 1 quart.)	Mn/DOT 5-693.920	2360.4E12

(D) 2360.4 E2 shall be deleted

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- (E) The Title of 2360.4 E10 is hereby modified to read as follows:
Aggregate Specific Gravity (G_{sb}) and Aggregate AbsorptionAASHTO T84 and T85 MnDOT modified
- (F) 2360.4 E13 is hereby added:
E13 Draindown Test..... AASHTO T305
Draindown that exceeds 0.3% is unacceptable. The Contractor shall take appropriate action to bring draindown values into specification. This action may include checking to determine if the stabilizer is being added, if the rate of adding stabilizer is correct and checking if the mixing temperature is excessive. The draindown test shall be performed at the production plant mixing temperature.
- (G) 2360.4E14 is hereby added:
E14 Voids in Coarse Aggregate (VCA) Ratio Calculation AASHTO PP41-02
To select gradation, choose the gradation with the $VCA_{MIX} < VCA_{DRC}$ with high air voids.
- (H) Modify 2360.4F (2a) to include:
 - 15. If obtained, verification sample.
 - 16. VCA ratio
 - 17. Draindown value in %
- (I) Modify 2360.4 G to include:
 - (6) VCA ratio
 - (7) Draindown value in %
- (J) Modify Table 2360.4-H to read:

**Table 2360.4-H
JMF Limits (N=4)**

Item	JMF Limits
% G_{mm} @ N_{design} / Production Air Void	± 1.0
Asphalt Binder Content, Percent	± 0.4
Sieve - % Passing*	
19, 12.5, 9.5 mm (3/4", 1/2", 3/8")	± 4
4.75, 2.36 mm (No. 4, No. 8)	± 3
0.075 mm (No. 200)	± 2.0

* JMF target values are not allowed outside the broadband requirements in Table 2360.2-E.

S-1.5 CONSTRUCTION REQUIREMENTS

- (A) Modify 2360.5 B Restrictions to Read:
Placement of Porous HMA mixtures will be allowed only when the ambient air temperatures are at least 10C (50F).
- (B) Modify 2360.5C1a (7) to read:
Storage of the mix will be allowed during production at the risk of the Contractor and not to exceed 90 minutes.

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- (C) Modify 2360.5C2a to read:

HMA shall be placed with a track paver.

- (D) Modify 2360.5C2b to read:

The HMA shall be covered.

- (E) Modify 2360.5D1 to include:

A uniform lower rate of application may be 0.01 – 0.02 gallons per square yard (undiluted) or 0.02 - 0.04 gallons per square yard (diluted).

- (F) Modify 2360.5F to include:

For multiple lift construction, the Engineer and Contractor may elect to mutually agree to criss-cross the previously placed strip (lift) prior to placement operations.

S-1.6

PAVEMENT DENSITY

- (A) 2360.6 Pavement Density is hereby modified to read:

All compaction shall be by the Ordinary Compaction Method. Compaction of the hot-mix asphalt shall take place when the surface is cool enough to resist a 10-ton steel-wheeled roller [vibratory mode not allowed]. One or two passes is all that is required for proper compaction. More rolling could cause a reduction in the surface porosity which is unacceptable. Vibratory rollers and/or pneumatic-tired rollers are not allowed.

- (B) 2360.6 C4 Trench Rollers is here by changed to read:

C4 Trench Rollers

Trench rollers shall be self propelled and have a mass of not less than 2,960 pounds per foot of width.

- (C) 2360.6 C5 C5 Mixture Temperature Controls is here by changed to read:

C5 Mixture Temperature Controls

Unless directed by the Engineer in writing, no paving is allowed under the Ordinary Compaction Method when the air temperature is below 50°F when measured away from artificial heat. The minimum laydown temperature of the bituminous mix shall be 275 degrees Fahrenheit.

- (D) Other Guidance on Ordinary Compaction of HMA

- 1) Transporting of mix to the site shall be in vehicles with smooth, clean dump beds that have been sprayed with a non-petroleum release agent.
- 2) The porous bituminous courses shall be laid directly over the storage bed and stone base course to the specified finished thickness.
- 3) After final rolling, no vehicular traffic of any kind shall be permitted on the surface until cooling and hardening has taken place, and in no case within the first 24 hours.
- 4) Transition to adjacent impervious bituminous paving shall be merged neatly with flush, clean line. Finished paving shall be even, without pockets, and graded to elevations shown on drawing.
- 5) Porous pavement beds shall not be used for equipment or materials storage during construction, and under no circumstances shall vehicles be allowed to deposit soil on paved porous surfaces.

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- 6) Establish and maintain required lines and elevations. The Engineer shall be notified for review and approval of final stake lines for the work before construction work is to begin. Finished surfaces shall be true to grade and even, free of roller marks and free of low spots to form puddles. All areas must drain.

S-1.7

THICKNESS AND SURFACE SMOOTHNESS REQUIREMENTS

The first paragraph of 2360.7 A to is hereby modified to read as follows:

After compaction the thickness of the first lift on the aggregate base shall be within a tolerance of 12 mm [**1/2 inch**] of the thickness shown in the Plans. Each subsequent lift shall be within a tolerance of 6 mm [**1/4 inch**] of the thickness shown in the Plans. The Engineer may require removal and replacement, at the Contractor's expense, of any part of any lift that is constructed to less than the minimum required thickness.